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lations of Humboldt and the anthropogeographical theories of Ritter. It is because in either of these fields an enormous amount of positive knowledge of single facts is needed in order to generalize with any claim to accuracy, and that this very basis of the science appeared to him, at the time, rather indefinite and incomplete, that he wanted first of all to make sure of the facts themselves. Thus he holds, in the middle of the nineteenth century, a place entirely by himself, embodying the transition from the old speculative to the new empirical method in geography.

In the first appendix the author tells the story of Petermann's school and his most noteworthy disciples: Ravenstein, Hassenstein, Debes, Friederichsen, Habenicht, and others; the second illustrates the enormous working power of this unique personage, containing a list of his publications no less than 44 pages in length.

As a book of reference on a very interesting and little known phase of geographical life in Germany, the book is a very meritorious addition to the history of modern geography.

MARTHA KRUG GENTHE.

NOTES ON THE DESCRIPTION OF LAND FORMS.—VII.

GEOGRAPHICAL DESCRIPTIONS AS REFLECTIONS OF PREPARATORY EQUIPMENT. An observer ordinarily sees most distinctly and describes most definitely the kinds of things that he already knows most familiarly. This principle has two important corollaries:—first, that the intending observer will do well, before setting out on his travels, to extend his preparatory equipment as far as possible, so as to become familiar with many kinds of things and thus be ready to recognize them at sight; second, that he will do well, when his travels are under way, to give particular attention to the things that do not readily find mental counterparts in his preparatory equipment, for these things may be novelties of special value.

It is instructive, when one reads the description of a distant region, to bear this principle and its corollaries in mind, with a view of discovering the schemes of treatment in which the observer had been previously instructed, and of determining the sufficiency of these schemes for the presentation of the facts that lay before him.

THE ARGENTINE CORDILLERA. F. Kühn. Beiträge zur Kenntnis der Argentinischen Cordillere zwischen 24° und 26° südl. Br. (*Zeitschr. Gesellsch. für Erdk.* Berlin, 1911, 147-172). The difficult journey over the desert highland basins of the Andean Cordillera between Salta in northwest Argentina and Taltal on the Chilean coast offers rich opportunity for the observation and description of a great variety of landscapes, many of which are clearly set forth, for the most part in explanatory terms, in the article above cited. Particularly interesting is Kühn's clear exposition of the striking contrast between the deeply

incised eastern slope of Atlantic drainage, and the many saline basins among the irregular ridges of the lofty interior highland. The eastern slope is characterized by erosional valleys; the highland is frequently occupied by aggradational plains. The eastern valley system that was ascended by Kühn has an open longitudinal stretch (Calcachi valley) discharging southward, with narrower transverse valleys joining it from the west. The longitudinal stretch (3,000 m.) has been aggraded, probably by glacial outwash (?), and now shows two or three terraces, of which the lowest one is 80 m. above the stream, its scarp being much dissected by lateral gulches (barrancas). One of the transverse branch valleys, descending from the southern side of the Nevado de Cachi (6,000 m. +), has been glaciated: it heads in a cirque (4,700 m. ?), below which the floor of the glacial trough has a steep rock step; farther down stream the valley is encumbered with moraines (4,350 m. ?) and by a multitude of erratic boulders (3,400 m.). Another transverse valley, drained by an ungraded stream, shows several alternations between deep-cut, narrow, rock-walled gorges, and more open portions in one of which landslides occupy the valley floor (as if the rock resistance varied along the valley course?); but in its upper part this young valley is continued in a lofty and broadly open trough (4,500 m.) of gentle northward ascent, bordered by broad, round, waste-covered ridges. A lava stream from an unvisited vent to the north lies on the trough floor. To the west, a waste-covered saddle (4,950 m.) affords passage to the interior highland.

The highland, at a general altitude of some 4,000 meters, is a region of ridges and basins; the waste that is removed, chiefly by arid weathering, from the ridges goes to aggrade the basins and hence to diminish the local relief. Stony gravel fans, shown on the route map to be frequently laterally confluent, descend from a high eastern range and stretch in long gentle slopes across a longitudinal depression toward the lower ridges within the highland. The saline mud plains of the basins are described in some detail. Volcanoes and lava flows of recent eruption are abundant, especially along the western border of the highland. The few pasture grounds in the highland are important stopping places for the cattle that are driven over from the Argentine pampas to the lowlands of Chile.

All the physiographic features here mentioned are evidently examples of kinds of things previously known to the observer; and they are very effectively set forth in terms that had become familiar to him by previous study. It is indeed interesting to note how well the terms that he employs appear to serve their purpose. But there are two large questions raised by the facts as thus presented, to which no explicit answer is found in Kühn's article:—one is the possibility that the Cordillera is a two-cycle mountain range; the other concerns the stage in the arid cycle now reached by the highland basins. The impression gained after a careful reading of Kühn's pages is that these questions remain

unanswered, not because they are unanswerable, not even because their answer is particularly difficult, but because the questions themselves were not raised in the observer's mind; in other words, because the systematic treatment of two-cycle mountain ranges and the theoretical scheme of the evolution of arid regions were not parts of the observer's preparatory equipment.

As to the one- or two-cycle origin of the Cordillera:—its highlands are described as occupying a zone that has suffered folding in combination with powerful upheaval. The ranges often exhibit the most beautiful folded structure (*die schönsten Faltengebirge*, p. 165); but the original surface of deformation is no longer visible, because the ridges have shed their waste to aggrade the depressions. This might be taken to imply that the ranges of the highland were not far advanced in the cycle of erosion that was initiated by the folding of their strata. On the other hand, the rounded, waste-covered ridges that border the lofty, gently sloping, broadly open trough, above the narrow, deeply incised young gorge of one of the eastern transverse valleys, strongly suggests the two-cycle origin of the highlands; the earlier cycle apparently having been initiated by strong deformation, and having advanced during a lower stand of the region far towards old age, before it was interrupted by a broad uplift, with undetermined warping and faulting, whereby the current cycle, now in an early stage, was introduced. This interpretation is supported by what Keidel has reported of other parts of the Argentine Cordillera, and Bowman of the Bolivian. Yet the reader must hesitate to decide definitely in favor of the two-cycle origin of the Cordillera hereabouts, because such an origin is not explicitly announced by the observer; and it is notoriously dangerous to extend an observer's conclusions beyond the reach that he gave them himself.

As to the stage of the arid cycle represented by the highland basins, the reader must again remain in doubt. True, it is clearly set forth that the basins are gaining at the expense of the ridges; that certain valley floors slope two ways from a valley-floor divide; and that there are several independent salt plain basins, as is shown on the neatly drawn route-map. Thus the basins would seem, as a whole, to be in the early stage of arid evolution, represented by many separate initial basins, each of which receives centripetal inwash from its more or less modified initial drainage area; but whether a later stage is here and there attained, involving the incipient integration of arid drainage by the delivery of waste from higher, well-filled basins across low divides to lower basins, accompanied by the trenching of the divides, cannot be made out, interesting as actual examples of this hypothetically inferred stage of evolution would be. This phase of the problem of the arid cycle does not seem to have been presented as a subject for the observer's inquiry; hence his descriptions do not suffice for its safe solution. Another phase of the same problem here encountered is that of the exportation of dust from the interior area by wind action. The wind on the highland is described as prevailingly brisk; wind-

carved rock ledges are mentioned; faceted pebbles are noted on the gravel plains; but dunes are said to be of rare occurrence. In view of the strong relief of the highland borders, and of the way in which the saline mud plains seem to be rising upon the flanks of the ridges that enclose them, the reader may infer that the wash of waste into the basins, aided by the binding action of hygroscopic salts in holding the inwashed waste, prevails over the exportation of dust by the winds, as might be expected by the case in the early stage of the arid cycle already indicated by the occurrence of independent basins; but here again, a word or two in expression of the observer's opinion, based upon what he saw and thought while on the ground, would be a valuable support for a reader's inferences.

Still a third phase of the evolution of a high-level, interior arid highland is passed over without explicit consideration; namely, the stage of encroachment of exterior on interior drainage. The hypothetical aspects of this part of the problem are clear enough: the exterior streams must cut their valleys headward by retrogressive erosion, and must eventually encroach upon the original high-standing interior drainage area. One by one, the interior basins will be captured by exterior streams; their aggraded waste-plains will be rapidly dissected and removed, and their rock floors will be attacked. Some of the high-standing basins of southern Tibet and of western Mexico seem to have been thus invaded by the retrogressive headwaters of exterior rivers; but in Tibet and Mexico as well as in the Andean Cordilleras, the accounts by various observers still leave too much of the story to the imaginative inference of their readers. Yet it would evidently be an aid to a reader who wishes to form a clear picture of an interior highland to know definitely whether the attack of the retrogressive exterior streams is as yet only in so early a stage that the capture of interior drainage is a remote contingency—as would seem to be the case in the district traversed by Kühn; or whether the initial divide around the rim of the interior area has already here and there been pushed inward a little by some of the more aggressive exterior streams; or whether the encroachment has gone on so far that some of the basins are in imminent danger of capture and diversion to exterior drainage systems; or whether some captures have actually taken place, and if so, what advance has been made in the rapid dissection of the waste-plains; for if these stages are correctly interpreted by the observer and correspondingly understood by the reader, the various features that are associated with each stage and implied in its mere mention will go far in enabling the reader to conceive what the observer actually saw. But at present the generalized problem of the cycle of arid erosion is so seldom recognized or taught, that the observers who travel in desert highlands have not yet had opportunity to acquire an understanding of it as part of their preparatory equipment; and various theoretical phases of the arid cycle therefore remain as yet unmatched by their actual counterparts.

It is important to emphasize a certain aspect of the systematic and explanatory treatment of land forms, here advocated. It should be carefully recognized that the object of determining the earlier stages in the history of a mountain range, or the later stages in the history of a highland basin, is not simply in order to know the past condition of the one, or the future condition of the other, but in order better to describe their present condition. The past condition of an existing mountain range is truly in itself an interesting matter for geologists; the future condition of an existing highland basin is also in itself an interesting subject for speculation, though no name has yet been given to the prophetic science to which such a speculation would belong. Why it is that the present form of both the mountain range and the highland basin—a proper subject of geographical study—can be better understood if it is described in terms of the past or the future forms, instead of in terms of itself, will be pointed out in a future Note.

GRUNDZÜGE DER OBERFLÄCHENGESTALTUNG CORNWALLS. H. Spethmann. (*Globus*, xciv, 1908, 329-333, 347-350). This discriminating article describes the upland, the valleys and the coast of Cornwall with greater fullness and with clearer appreciation of modern physiographic methods than does any English article that has come to my attention. The discussion of the means of distinguishing between two possible origins of the upland—as a peneplain of subaerial erosion, now uplifted and submaturely dissected, or as a plain of marine abrasion, similarly uplifted and dissected—is an unusually careful piece of work, revealing elaborately developed theoretical schemes of normal and marine cycles of erosion as a part of the observer's equipment. He concludes that the upland in the Lands End district is a plain of marine abrasion, because the subdued granitic residuals which surmount it do not occupy the whole of the granitic areas; this conclusion being preceded by the explanatory inferences that, if the upland were of subaerial erosion, the borders of the residual elevations ought to coincide with the boundaries of the harder rocks, while if it were of marine abrasion, the border of an unconsumed island might lie well within the boundary of the harder rocks, and might, because of the selective progress of marine abrasion, be very irregular in its alternation between headlands and coves.

These inferences and the conclusions to which they lead afford occasion for emphasizing another general principle of geographical description, as important as the one stated at the beginning of this number of these Notes; namely, that the observer and his readers must have identical or at least similar equipments, if the reports of the former are to be easily understood and fully accepted by the latter. A difficulty arises in the way of accepting some of Spethmann's results, because certain late stages in the marine and the normal cycles of erosion may be conceived differently from his conception of them, as follows:—First, a residual or monadnock surmounting a peneplain (for which

Spethmann suggests the convenient German term, *Härtling*), in a late stage of an undisturbed cycle, may occupy the whole area of the hard rock that determines it, as in the upper block of Fig. 1; but in a still later stage the border of the monadnock may shrink within the boundary of its hard rocks, as in the lower block; and in thus shrinking, many minor irregularities may be developed in its border by reason of slight inequalities in its structure. Hence irregularity of outline and lack of coincidence between the base of a low monadnock and its hard-rock area should not at once be taken as indicative of the marine origin of the surrounding plain.

Second, a residual island may be reduced to a smaller area than that of the hard rocks which determine its survival in an advanced stage of a marine

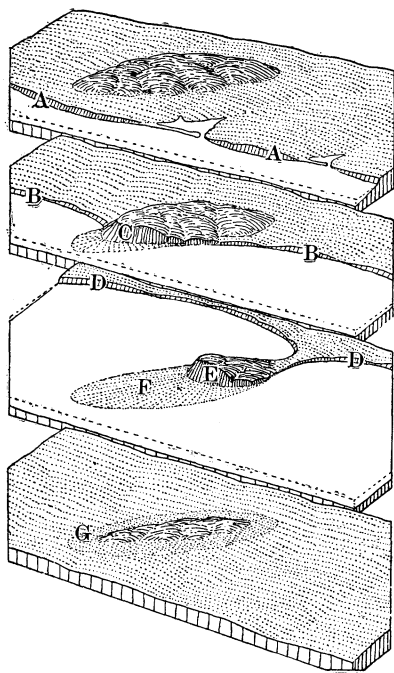


FIG. 1.

cycle, but its border must then have a simple outline, free from narrow coves between headlands, because such details are produced by wave attack only in the early stages of the marine cycle; they must disappear in the stages so advanced that the island is subdued to low relief by normal erosion, for selective marine attack is then prevented by the presence of a well-developed beach along the far-retrograded shore line. The facts reported by Spethmann would, therefore, according to my interpretation, reverse his conclusion:—the upland about Lands End may be regarded as of subaerial origin, and the gravels that lie on it, bearing marine fossils, may be regarded as the result of a short-lived submergence after the district had been reduced to low relief by normal erosion.

There is another means of discriminating between plains of marine and of subaerial degradation, to which little if any attention has been given. If a region of complex structure is attacked by normal and by marine agencies, the marine agencies being aided by a slow depression of the region during their advancing work, then when a monadnock is reached, it will come to form a headland with higher cliffs C, Fig. 1, than those on the weaker rocks near by, B, B. As retrogression of the cliffs continues, the headland will become a peninsula, with cliffed front, E, and a sloping back. If at either of these

stages, elevation should occur, the surface of the greater part of the marine plain, abraded on the less resistant rocks (unshaded in Fig. 1), would be more nearly level than the small part of it which slopes forward from the cliff of the partly destroyed monadnock across the abraded part of its hard rock area. This is more clearly seen in the larger scale of Fig. 2, where A,A represents

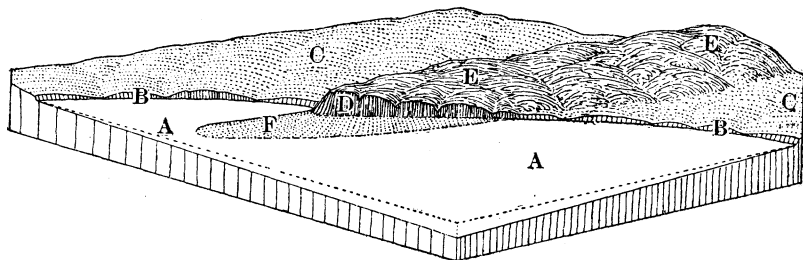


FIG. 2.

the smoothly abraded marine plain; B,B, the low cliffs along the border of the peneplain, C,C; and D, the higher cliffs at the front of the promontory formed by the exposed part of the monadnock-ridge, E,E. Of all these features, the abraded slope F, beveled on the hard rocks of the monadnock, is one of the most significant; its declivity will be about as much steeper than that of the plain, A,A, as the retreat of the higher cliffs, D, is slower than that of the lower cliffs, B,B. Even if no slow submergence accompanies marine abrasion, both the marine plain and the beveled slope must decline gently towards the sea; for the first abraded, outer part of a marine plain will be worn down somewhat while the sea retrogrades the coastal cliffs some miles into the land.

The upshot of this is, that if an upland is described as an uplifted plain of marine abrasion, features such as are shown in Fig. 2 ought to be identified along its inner margin, and especially around the exposed borders of its former headlands and islands. If no such features are found, and if instead the residual reliefs slope gradually down to the neighboring upland surface, with their base at the border of the determining hard-rock area, as in the upper block of Fig. 1, or shrunk inside of the boundary, as in the lower block, then the upland is better described as an uplifted peneplain of normal erosion, even if marine gravels, suggesting a temporary submergence, lie here and there upon it.

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